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Performance Comparisons of Space Borne Liquid Helium Cryostats

W.HOLMES, H.CHO, I. HAHN, M. LARSON*
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91106

R. SCHWEIKERT, S.VOLZ
Ball Aerospace and Technology Corp.
1600 Commerce St.
Boulder, CO 80301

We discuss the performance of liquid helium cryostats that have flown in space or are planned for space flight. Usual figures of merit are mass or evaporation rate, R, of the liquid cryogen on orbit. These often fail to accurately represent other key characteristics which effect performance such as the method used to survive launch lock-up, shape of the helium tank, or the temperature of the cryostat vacuum shell, T_{shell}, obtained by radiative cooling. To address this issue, we calculate the ratio, $[A_{tank}(T^4_{shell} - T^4_{tank})]/R$, where A_{tank} is the surface area of the helium tank, and T_{tank}, is the cryogen temperature, as a metric. Surprisingly, the ratio is ~2 for 4 flight cryostats (ISO, IBSS, IRT, SFHe/LPE/CHeX), which had T_{shell} ranging from 113K (ISO) to 300K (SFHe). The ratio is slightly higher for COBE (~5) and IRAS (~9). The best cryostat deployed in space, using this metric, is IRTS (Infrared Telescope in Space), flown by NASDA, with a ratio ~13. We compare liquid helium cryostats designed for space flight that are currently under development using the standard metrics and the ratio.